Completed Project (2011 - 2014)

Nuclear Systems (NS): Technology Demonstration Unit (TDU) Project

Game Changing Development Program | Space Technology Mission Directorate (STMD)

ANTICIPATED BENEFITS

To NASA funded missions:

•Nuclear systems provide power anywhere within the solar system •Nuclear power systems are lower mass than photovoltaic power systems with regenerative fuel cells: 75% mass reduction – Mars surface mission 90% mass reduction – Lunar equatorial mission 75% mass reduction – Lunar south pole mission

DETAILED DESCRIPTION

The Nuclear Systems Project demonstrates nuclear power technology readiness to support the goals of NASA's Space Technology Mission Directorate. To this end, the project will: Demonstrate subsystem-level technology readiness in a relevant environment (Technology Readiness Level (TRL) 5) Establish a hardware-based technical foundation for fission power system (FPS) design concepts and reduce risk Validate a FPS concept that meets exploration power requirements at reasonable cost with added benefits over competitive options Reduce the cost uncertainties for FPS and establish greater credibility for flight system cost estimates Generate the key gate products that will allow Agency decision-makers to consider fission power as a viable option to proceed to flight development The Nuclear Systems Project is aligned with STMD's Roadmap on Space Power and Energy Storage (TA-03) and addresses a key milestone for a non-nuclear subsystem demonstration of a "workhorse" 10-100 kWe fission system. The National Research Council's review of the STMD Roadmap identifies Fission Power Generation as one of the top 16 NASA technology development priorities. The STMD Roadmap clearly recognizes the importance of the planned non-nuclear demonstration as a crucial step in deploying an initial space fission system and a foundation for follow-on fission power system technology development. While the 10-100 kWe class system is ideally

Fission Power System Technology Demonstration Unit in GRC Vacuum Facility 6.

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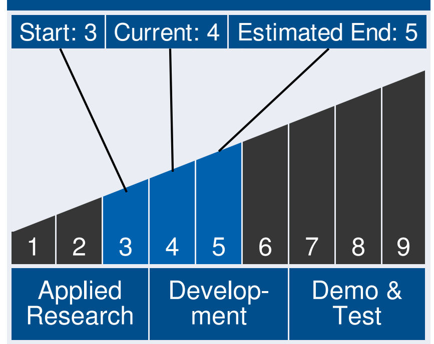
Technology Maturity



Management Team

Program Executive:

- Lanetra Tate

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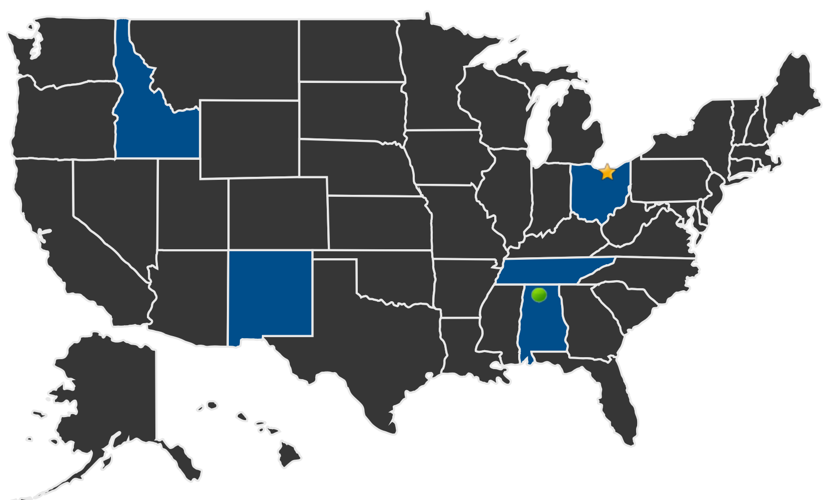
suited for lunar and Mars surface power, the component technologies are readily adaptable to larger megawatt-class systems for Nuclear Electric Propulsion (NEP) missions. Further, the analytical tools and non-nuclear testing strategies that will be exercised in this project can be applied to the megawatt systems as well as lower power (kilowatt-class) systems that may be needed for space science missions that exceed current Radioisotope Power System (RPS) capabilities.

U.S. WORK LOCATIONS AND KEY PARTNERS



U.S. States With Work

Lead Center:
Glenn Research Center

Supporting Centers:

- Marshall Space Flight Center

Other Organizations Performing Work:

- Department of Energy
- Sunpower, Inc. (Athens, OH)

Management Team *(cont.)*

Program Manager:

- Mary Wusk

Project Manager:

- Donald Palac

Principal Investigator:

- Charles Taylor

Technology Areas

Primary Technology Area:
Space Power and Energy Storage (TA 3)
└─ Power Generation (TA 3.1)
  └─ Fission (TA 3.1.5)
    └─ 1-10 kWe Stirling Fission Power System (TA 3.1.5.2)

Additional Technology Areas:
Space Power and Energy Storage (TA 3)
└─ Power Generation (TA 3.1)
  └─ Fission (TA 3.1.5)
    └─ 10-100 kWe Fission Power System with Stirling Conversion (TA 3.1.5.3)

DETAILS FOR TECHNOLOGY 1

Technology Title

Nuclear Systems: Technology Demonstration Unit

Technology Description

This technology is categorized as a hardware system for unmanned spaceflight

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- Demonstrate subsystem-level technology readiness in a relevant environment (Technology Readiness Level (TRL) 5)
- Establish a hardware-based technical foundation for fission power system (FPS) design concepts and reduce risk
- Validate a FPS concept that meets exploration power requirements at reasonable cost with added benefits over competitive options
- Reduce the cost uncertainties for FPS and establish greater credibility for flight system cost estimates
- Generate the key gate products that will allow Agency decision-makers to consider fission power as a viable option to proceed to flight development

The Nuclear Systems Project is aligned with STMD's Roadmap on Space Power and Energy Storage (TA-03) and addresses a key milestone for a non-nuclear subsystem demonstration of a "workhorse" 10-100 kWe fission system. The National Research Council's review of the STMD Roadmap identifies Fission Power Generation as one of the top 16 NASA technology development priorities. The STMD Roadmap clearly recognizes the importance of the planned non-nuclear demonstration as a crucial step in deploying an initial space fission system and a foundation for follow-on fission power system technology development. While the 10-100 kWe class system is ideally suited for lunar and Mars surface power, the component technologies are readily adaptable to larger megawatt-class systems for Nuclear Electric Propulsion (NEP) missions. Further, the analytical tools and non-nuclear testing strategies that will be exercised in this project can be applied to the megawatt systems as well as lower power (kilowatt-class) systems that may be needed for space science missions that exceed current Radioisotope Power System (RPS) capabilities.

Capabilities Provided

The Fission Surface Power system that is the reference configuration for the TDU can provide a robust power capability of 40 kWe resulting in substantial power margin for early lunar or Mars outpost build-up and operations. It can also provide capacity for power increases associated with the initial surface elements and the potential for expanded science and resource utilization. It is readily scalable between 10 and 100 kWe, and elements of this technology are applicable to smaller fission systems for science and robotic precursor missions needing as little as 1 kWe power. Fission power systems, like their radioisotope power system cousins that have provided power for Voyager and many other deep space science missions for decades past their design life, are inherently long-lived and impervious to most environmental conditions that exist in our solar system.

Potential Applications

Beginning with the Exploration Systems Architecture Study (ESAS) in 2005, NASA has conducted various mission architecture studies to evaluate implementation options for the U.S. Space Policy (formerly the Vision for Space Exploration). Several of the studies examined the use of fission power systems for human missions to the lunar and Martian surface. Currently, NASA's Mars planners continue to recognize the need for nuclear fission power for human exploration on the surface of Mars, and are examining options for fission power system deployment on Mars, as well as options for demonstration of fission power technology in space prior to human Mars surface missions.